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Experimental Physics 5

Long-term monitoring of Blazars – the DWARF network

Blazars hosting Binary Black Holes?
Blazars as hadronic accelerators?
Monitoring with state of the art IACTs?
DWARF: A global IACT network
Summary

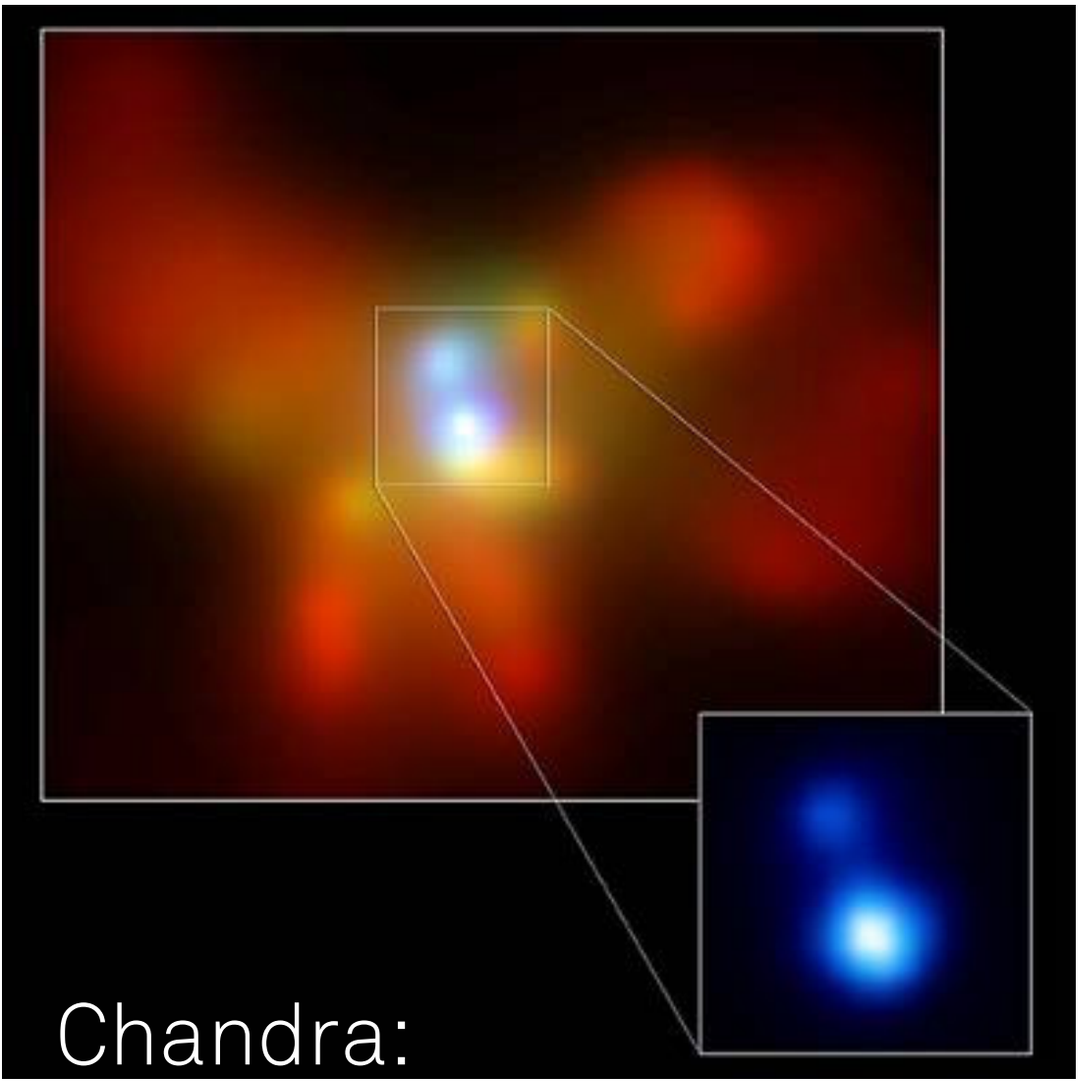
Michael Backes
for the DWARF collaboration

Acknowledging support of

DAAD Deutscher Akademischer Austausch Dienst
German Academic Exchange Service

Wilhelm und Else Heraeus-Stiftung

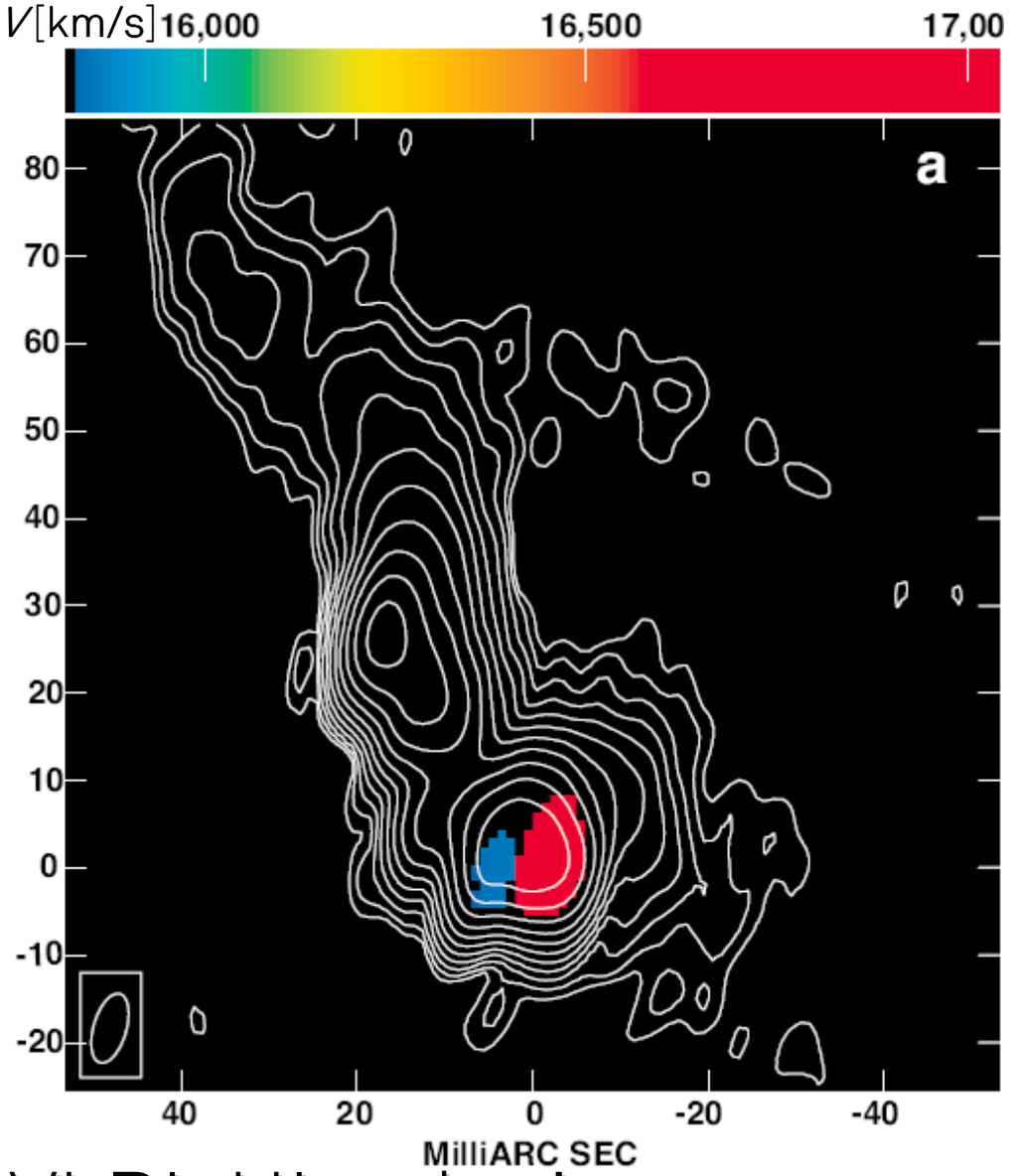
Binary BHs in AGN I: Evidences



Chandra:
NGC 6240: z=0.024;
d~1.4kpc, 2 active Nuclei
[Komossa+03]

- Natural expectation of hierarchical galaxy formation
  [e.g. Begelman+80]
- Discovery **wide** BBHs (left)
- Merger kick-off by asymmetric graviatational wave emission (?)
  [Komossa+08]
- Discovery of 1 narrow BBH (7pc)
  [Rodriguez+09]
- Are there close to coalescense sub-pc scale BBHs?

Binary BHs in AGN I: Evidences



VLBI: HI-velocity
0402+379: z=0.055; d~7pc

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  [e.g. Begelman+80]
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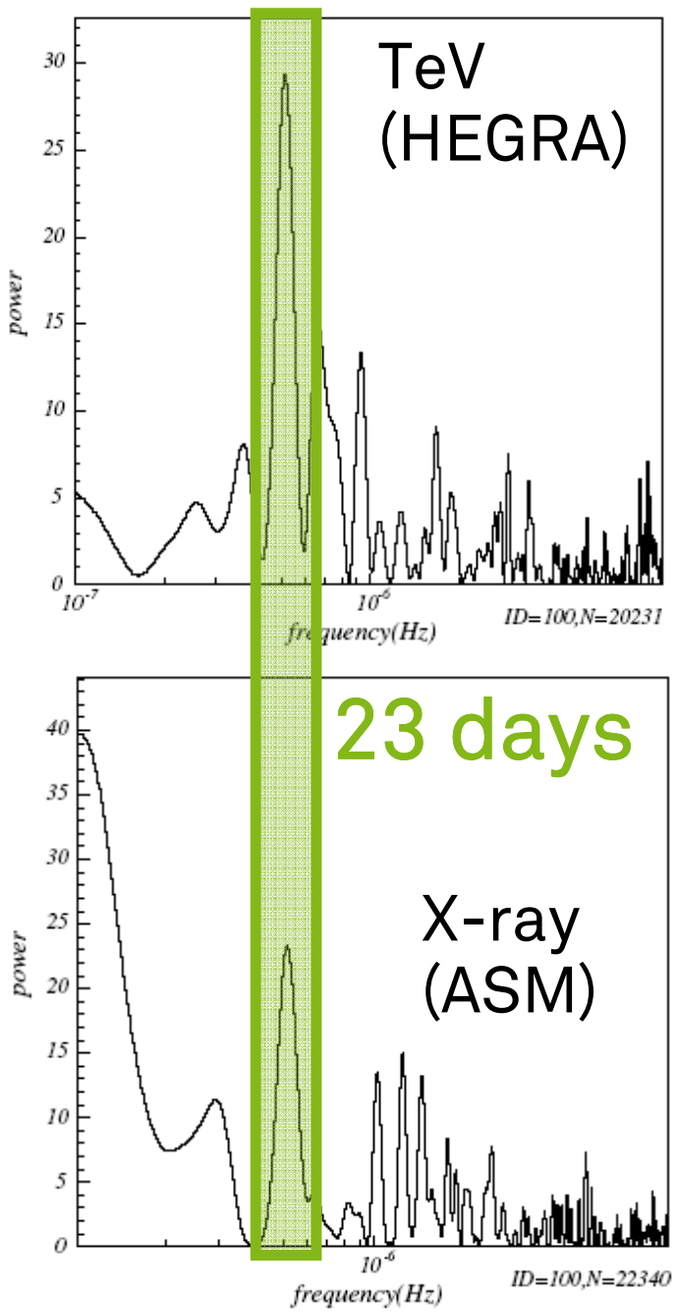
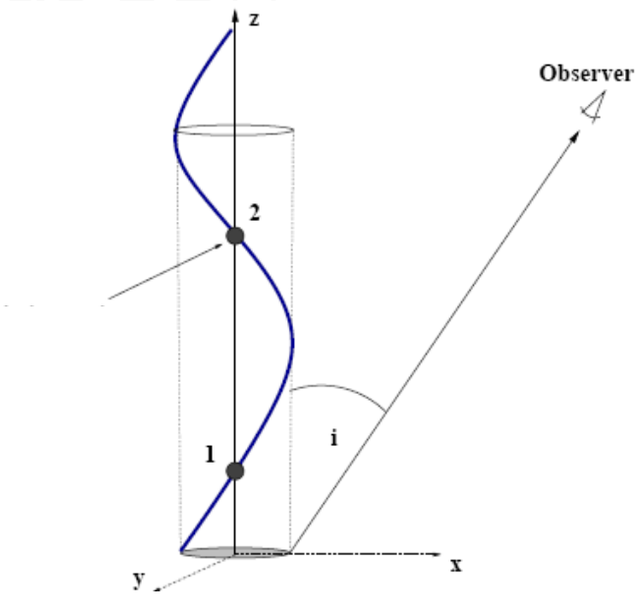
BBHs in AGN II: Blazars & QPOs



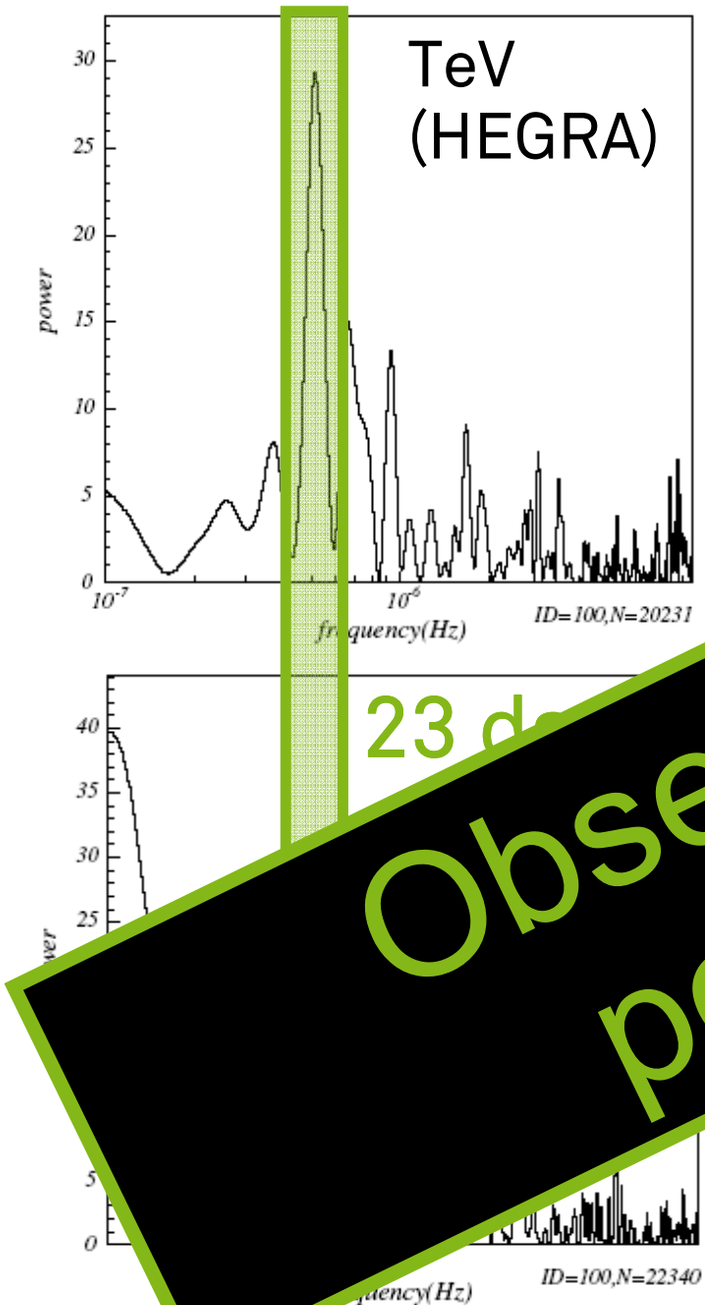
- Theory: quasars=narrow BBHs [Lobanov06]
- Not resolvable → QPOs
- OJ287: 12 yr optical [Sillanpää+87, Fan+98, Wu+06]
- Mkn501: TeV& X-ray 23d [Kranich+99, Osone06]
  optical: 100d [Yang+08]
  new TeV & X-ray: 23d, 36d & 72d [Röding+09]
- Interpretation of TeV-QPO as BBH
  [Rieger & Mannheim00, De Paolis+02, Rieger07]

↳ Extract mass & distance

↳ Calculate GW templates



BBHs in AGN II: Blazars & QPOs



- Theory: quasars=narrow BB… nov06]
- Not resolvable → QPO…
- OJ287: 12 yr o… vu+06]
- Mkn501… 99, Osone06]
  op… [Yang+08]
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…of TeV-QPO as BBH

…ger & Mannheim00,
De Paolis+02, Rieger07

Extract mass & distance

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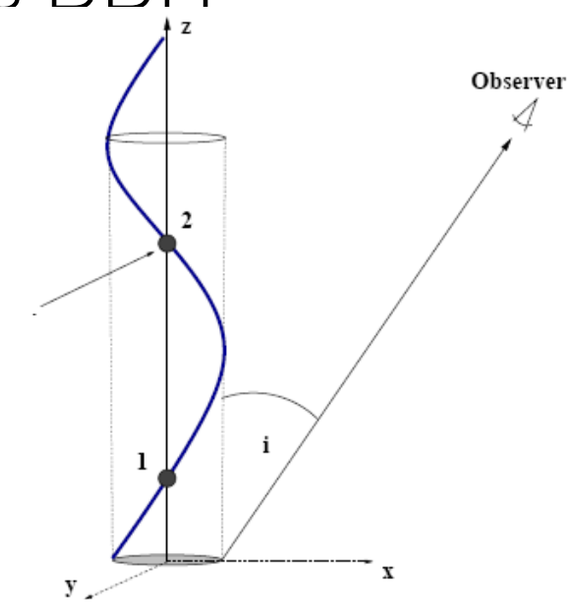
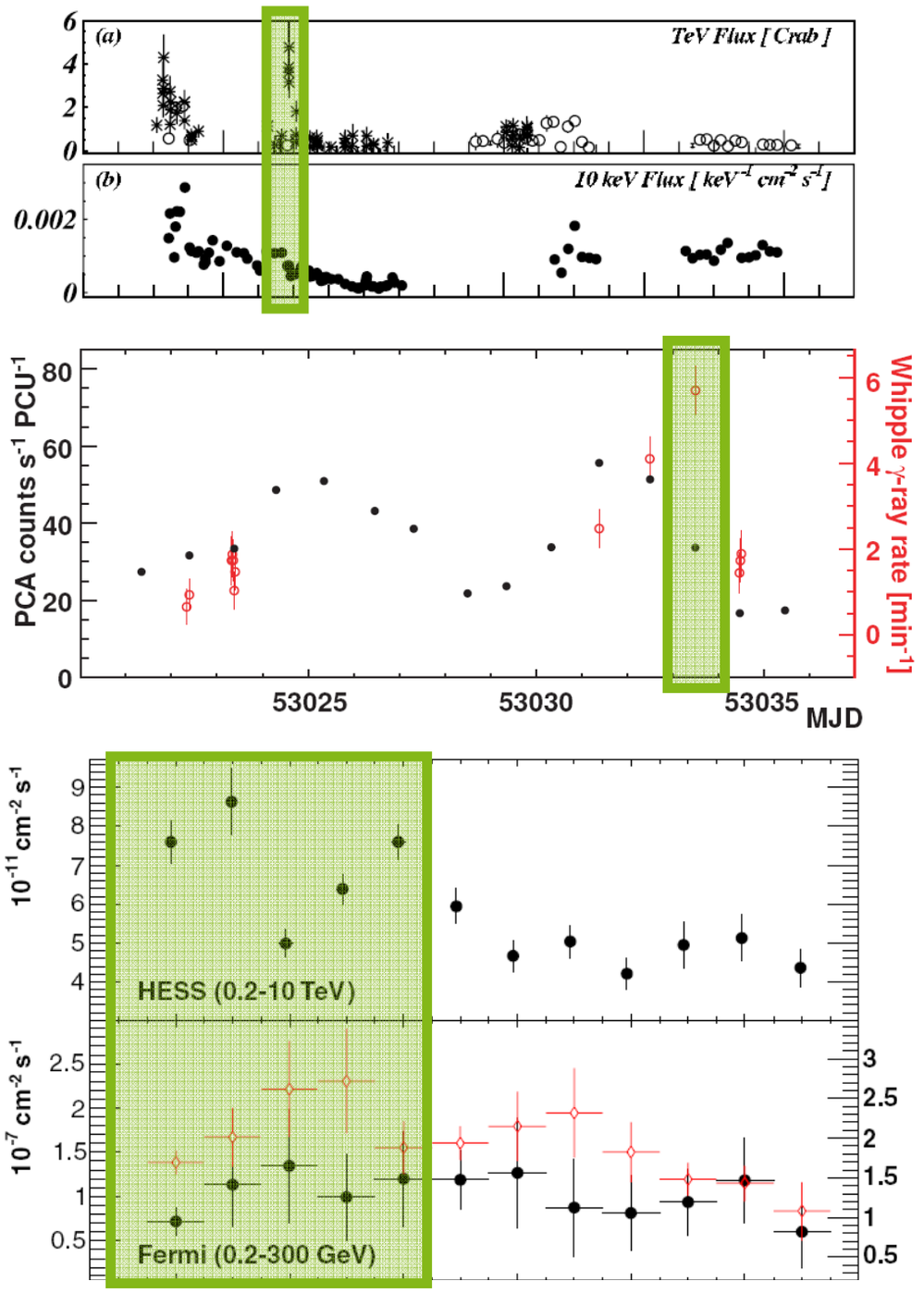


Observations of several periods mandatory!

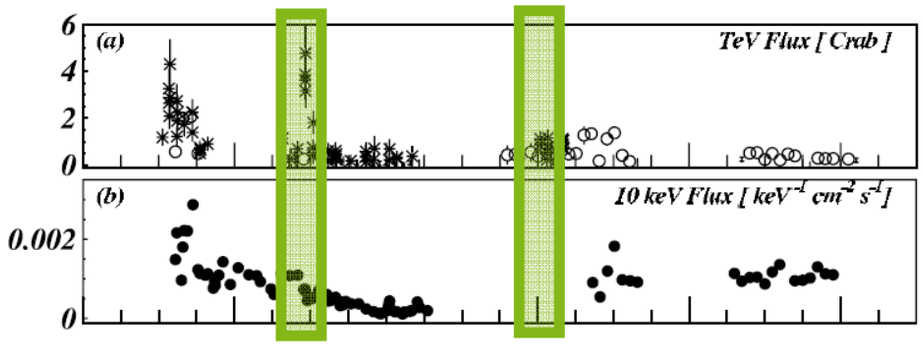
Hadronic orphan flares?



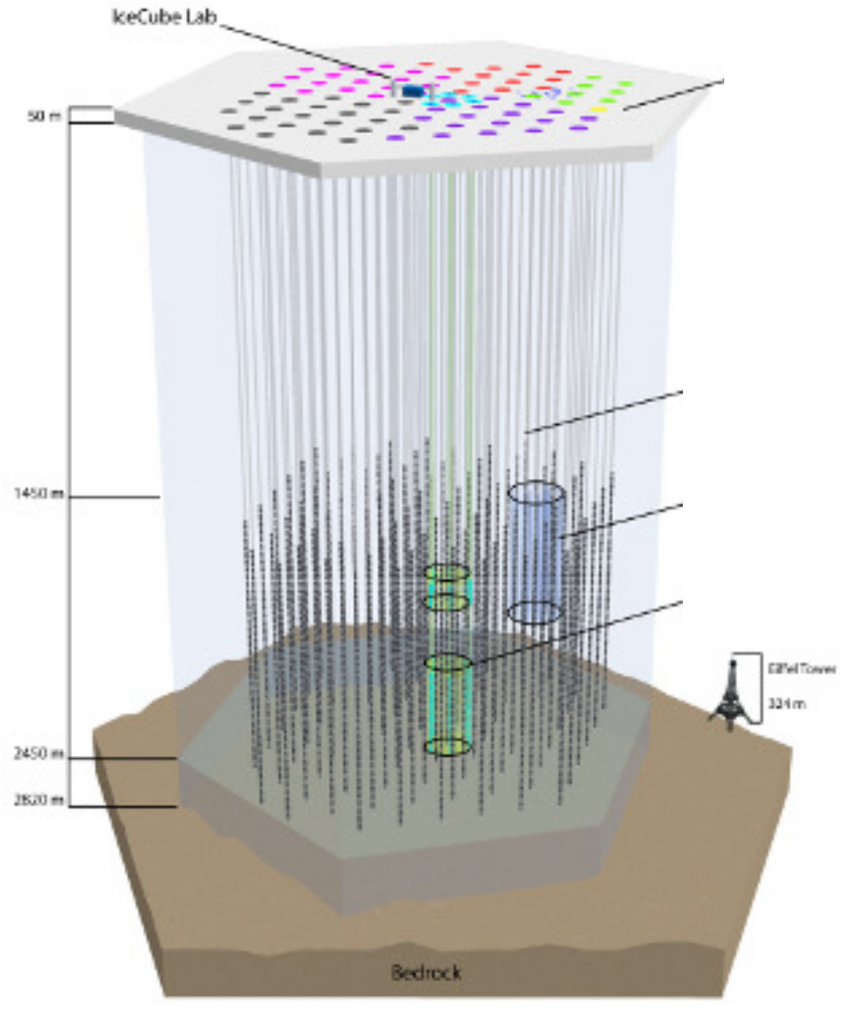
- Orphan TeV flare in 2002 of 1ES1959+650 [Krawczynski+04]
- „Orphan“ TeV flare in 2004 of Mkn 421 [Blazejowski+05]
- PKS 2155-304: GeV lightcurve compatible with constant while in TeV highly variable [Aharonian+09]

↳ Different origins of radiation?

ν's as smoking gun



- 2 ν within 66 days, 1 coincid. with orphan flare [Resconi05]



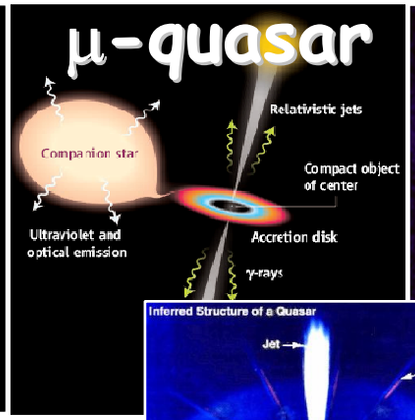
- 1-2 atm bg ν/yr/km³/deg² [Halzen+06]
- 2crab flare in 1h with 1ν / 1crab flare in 1d with 2ν >4σ [Godman+07]
- Completeness of γ-data statistically crucial [Leier+06]

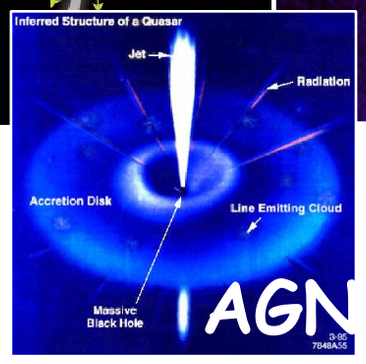
Complete observations mandatory!

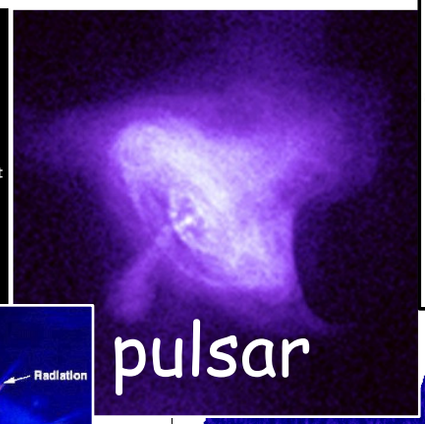
Monitoring with current IACTs?

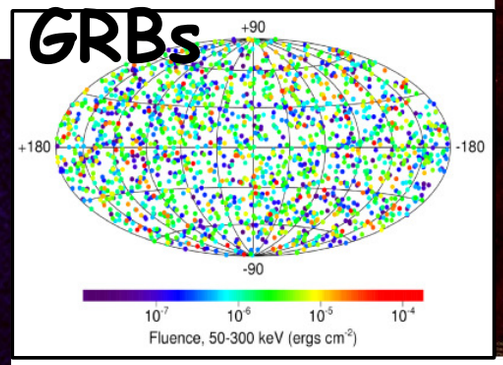
High sensitivity with threshold energies around 100 GeV

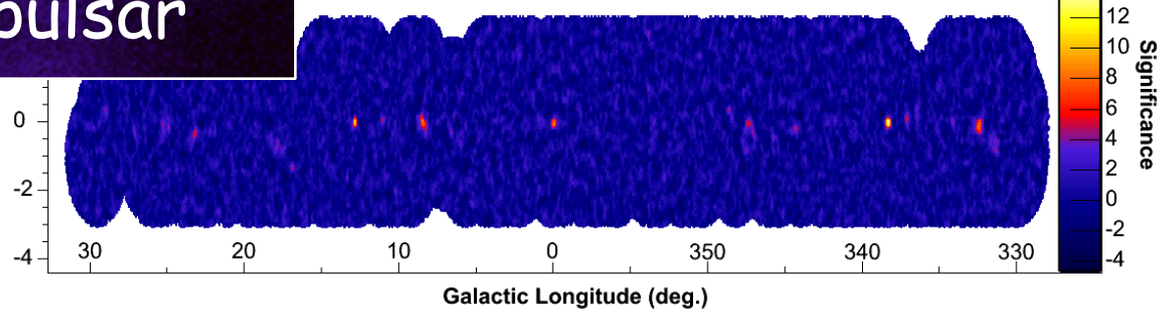
↳ many observation missions:











↳ no cost efficient way for 24/7 monitoring

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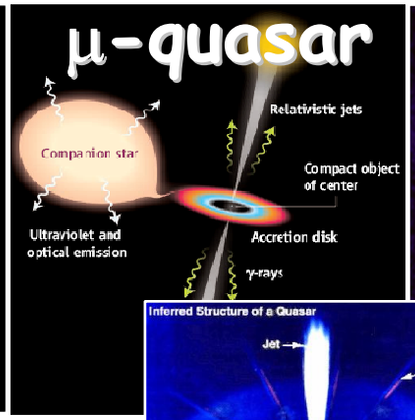

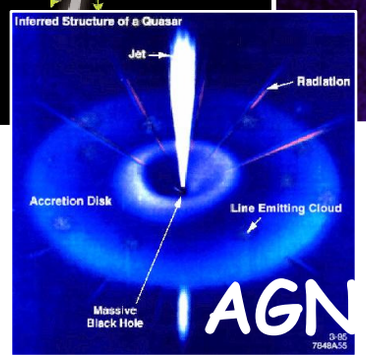

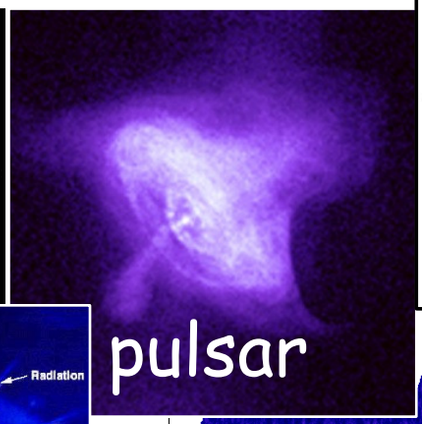

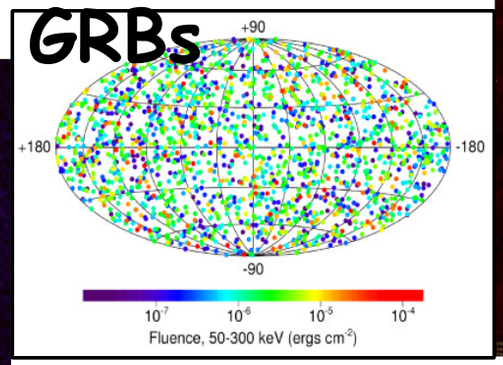

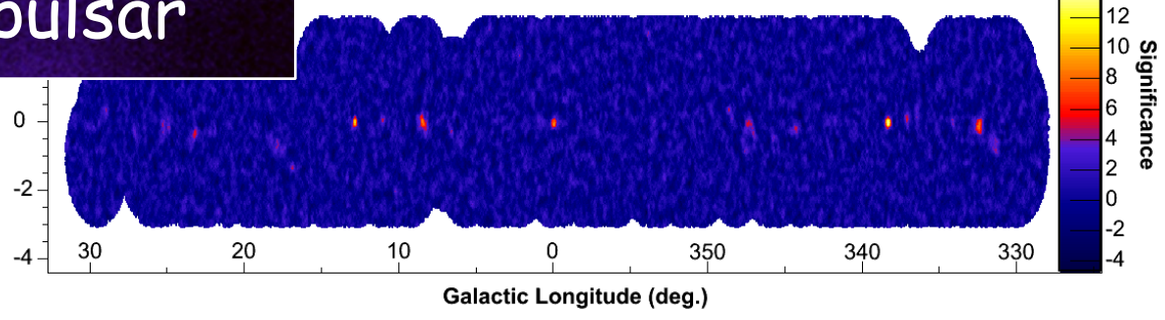

↳ no cost efficient way for 24/7 monitoring

➔Dedicated Worldwide Agn Research Facility (DWARF)

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The Dwarf telescope

→[Bretz: talk 1257]

MWL partner: Tuorla (optical) Metsähovi (radio), Fermi (GeV)

TU Dortmund, Uni Genf, ISDC Versoix, PSI Villigen, Uni Würzburg, ETH Zürich

- G-APD camera
  →[Krähenbühl: talk 1282, Weitzel: talk 1074]
- Solid light concentrators
  →[Braun: poster 1248]

↳ E_{th} ~400 GeV

- For flares giving ToO-alerts
- Continous MWL data (radio, optical, X-Ray, GeV & TeV)
- …24/7 monitoring?

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...more Cherenkov telescopes:

Whipple 10m

- 1 telescope
- Arizona (USA)

↳ E_{th} ~ 400 GeV

- Ongoing monitoring [Pichel: talk 636]

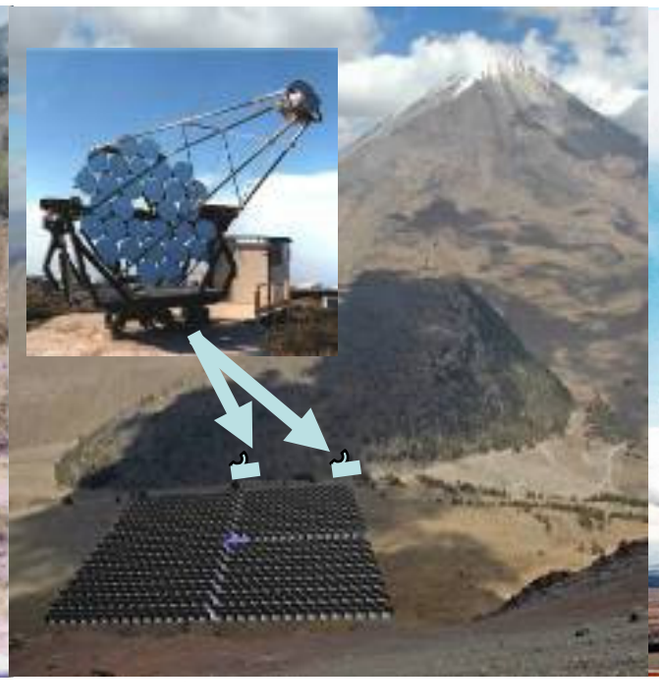
TACTIC

- 1 telescope
- Mt. Abu (IN)

↳ E_{th} ~ 1TeV

- Ongoing monitoring [Koul+07]

OMEGA



- 2 of HEGRA
- Sierra Negra (MEX)
- **4100m a.s.l.**

↳ E_{th} ~700 GeV→**???**

[Ruben+: Poster 868]

StarBase

- 2 of Telescope Array
- Utah (USA)
- 7.1m² mirror
- No Cherenkov-camera yet
- Int. Interferrometry [Kieda+08]

...more to come!

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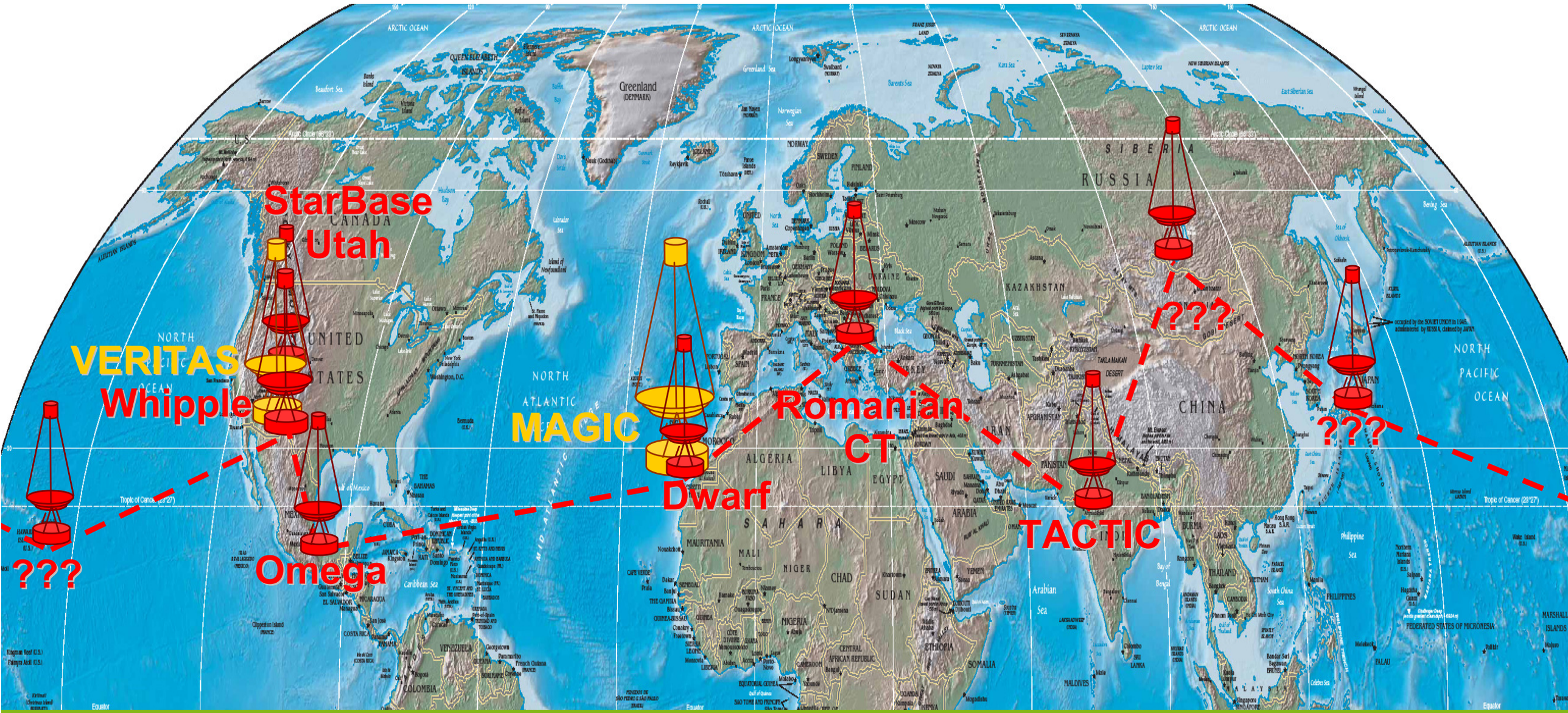
Global distributed DWARF network



Dedicated **W**orldwide **A**gn **R**esearch **F**acility

DWARF

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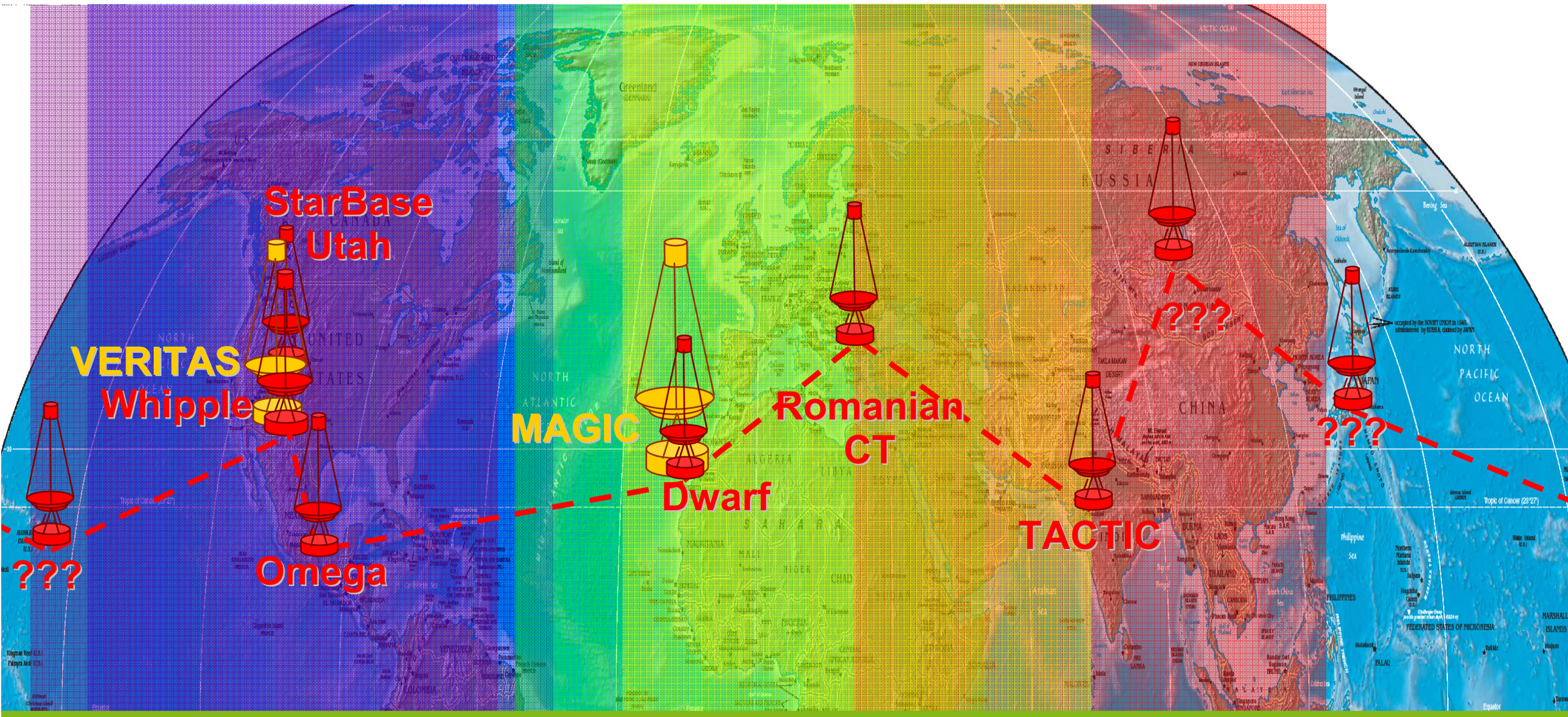
Global distributed DWARF network

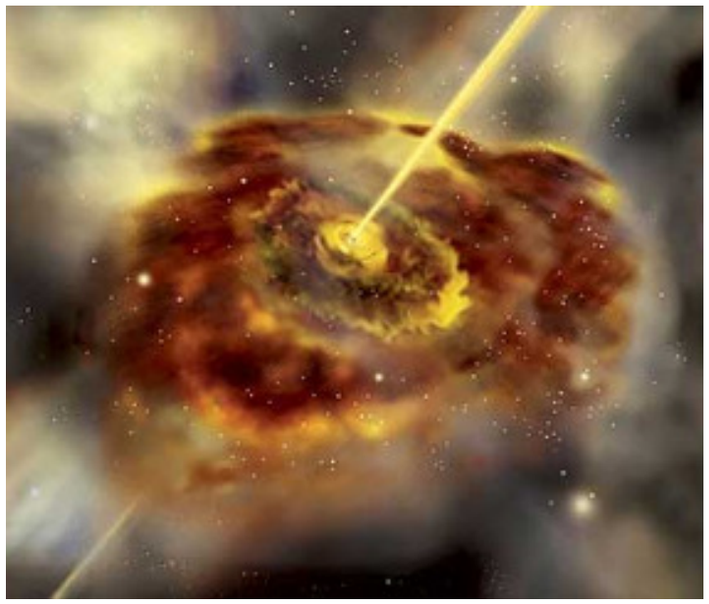


Dedicated Worldwide Agn Research Facility

DWARF

Summary

- Much interesting physics in monitoring, e.g.
  - Leptonic or hadronic jets?
  - Coincident γ- and ν-observations
  - Super Massive Binary Black Holes
  - Gravitational waves



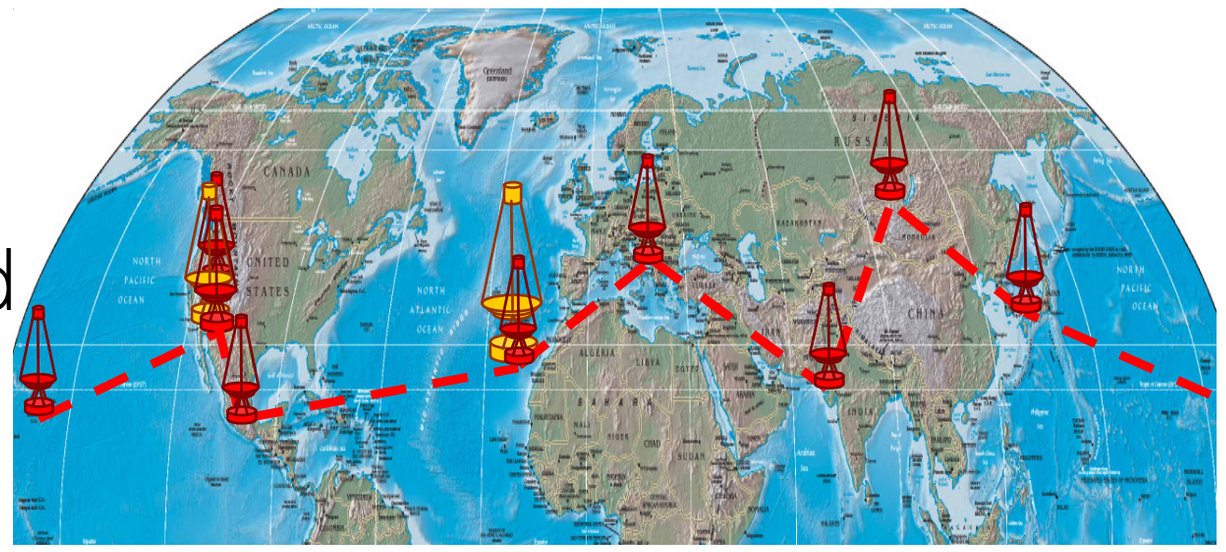
- Not cost-efficient with current IACTs

↳ **Dedicated telescopes** for long-term monitoring of strong sources:

DWARF

Network of distributed telescopes for

24/7 observations



Thank you!

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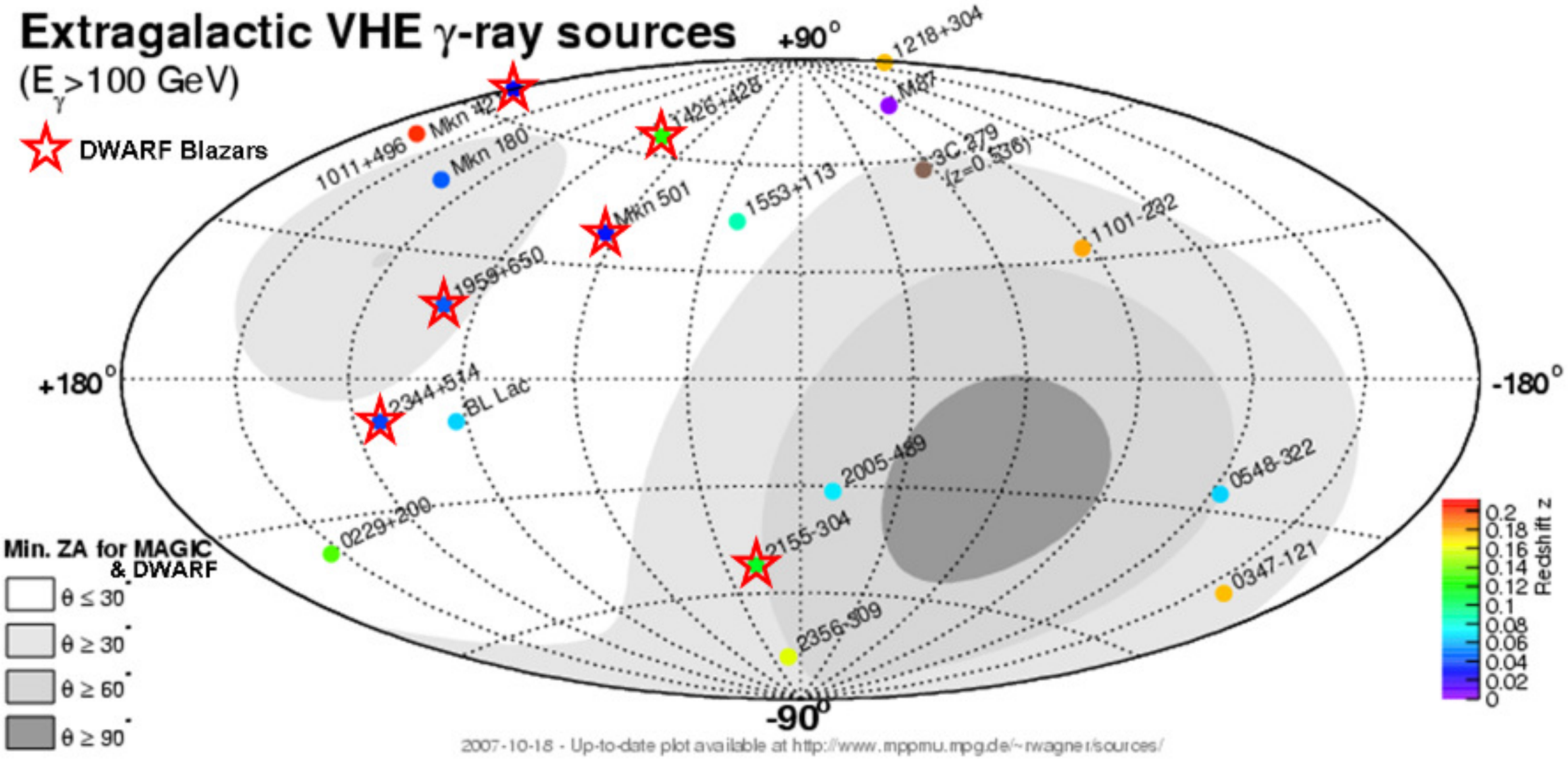
DWARF

Most probable DWARF sources



Mkn 501, Mkn 421, 1ES 1959+650, 1ES 2344+514,
H1426+428, PKS 2155-304